

# In-Depth Analysis of Municipal Solid Waste Management in Kanifing Municipality, The Gambia

Foday N.K. Fatty<sup>1</sup> and Lamin Komma<sup>2</sup>

<sup>1</sup>Institute of Environmental Management and Sustainable Development, College of Environmental Science and Engineering, Tongji University

<sup>2</sup>World Maritime University, Malmo, Sweden

DOI: 10.29322/IJSRP.9.11.2019.p95114

<http://dx.doi.org/10.29322/IJSRP.9.11.2019.p95114>

**Abstract-** Undoubtedly, inadequate municipal solid waste management in most developing countries is one of the major contributing factors to the present environmental pollution and risk to human health. This is influenced by increasing population, urbanization, industrialization, and economic development of a particular place resulting to the rise in waste stream and its complexity.

In the Gambia, Kanifing Municipality is one of most densely area and face with a huge challenge to the increasing volume of municipal solid waste produced and insufficient collection capacity. The generation and composition of MSW of this municipality is influenced by numerous factors, notable rise in the affluence of people and increase in population. The considerable growth of this municipality since 1993 has increased the generation of waste and its composition. As uphold in many research, MSW generation depends on the socioeconomic activities and the size of the population. This proved to be the case of the MSW generation and its composition in Knifing Municipality. Reviews of previous studies and reports indicated that major components of generated wastes were paper/cartons (83%), plastics (80%), organic matter (40%), metals (30%) and glass (27%). Studies also noted that, most of the waste generated by the commercial establishment can be recovered, recycled and more importantly, the generation of hazardous waste by the sector seems very negligible.

This paper investigates and analyze the current status and problems of Municipal Solid Waste Management (MSWM) in Kanifing Municipality based on gathered reports and papers to evaluate to what extent a viable reduction of the MSW can be implemented and management systems to be improved in the near future.

Currently, MSWM status and problems in this municipality is surrounded by an increase in the population couple with upsurge in affluent of inhabitants resulting in huge increase in the generation and composition of MSW. Comparing with the increasing rates of MSW generation, little has been done concerning its management. Therefore, an Integrated Waste Management System should be built in order to improve the holistic approach to enhance the sustainable MSWM system and reduce the impacts of waste to the environment and people at large.

**Index Terms-** Municipal Solid Waste generation, Solid waste management, Kanifing Municipality

## I. INTRODUCTION

Globally, pollution caused by solid waste poses a risk to human health and the environment. This has been accelerating in recent decade with higher than expected due to increasing population, urbanization, industrialization, and economic development contribute to the rise in waste stream and to increasing its complexity and riskiness[1]. Due to uncontrolled discriminate dumping and inappropriate waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies [2]. Solid wastes refers to all non-liquid wastes that arise from the activities of both human and animal and are discarded as useless or unwanted[3]. These include both organic and inorganic fractions such as kitchen refuse, product packaging, grass clippings, cloth, bottles, paper, paint cans, batteries, etc.

According to World Bank Report 2018, waste generation is projected to drastically surge from the current generation rate of 2.01 billion tons to 3.40 billion tons annually. Presently, the world is on a course where waste generation will considerably outpace population growth by more than double by 2050. An estimated of 13.5 % of today's waste is recycled and 5.5 % is composted (World Bank Report 2018). The report also estimated that between one-third and 40% of waste generated worldwide is not managed properly and instead dumped or openly burnt. These combine with global financial and economic instability, threats to health, and growing environmental degradation to affect all developing countries. These shared stressors shape national economics and people's livelihoods[4]. The types of solid waste generated in the municipality, includes mixed or similar wastes mainly from urban, peri-urban regions[5]. Municipal Solid Waste (MSW) is a waste that comes from households, garden waste or street sweepings are also considered and contents of litter containers. Solid waste encompasses all heterogeneous mass of throwaways from municipalities known as municipal solid waste as well as homogeneous accumulations from agricultural, industrial, commercial, and construction wastes[2]. However, the Basel Convention defines Municipal Solid Waste (MSW) as "Substances or objects that are disposed of, intended to be disposed of or are required to be disposed of by the provision of law." The management of these waste includes the control of its generation, storage, collection, transfer and transport, processing and disposal in a manner that is in accordance with the best principles of public health, economics, engineering, conservation,

aesthetics, public attitude and other environmental considerations[2].

In most countries especially developing countries, the management of municipal solid waste rest on the shoulders of the local government authorities or municipalities. However, the management of these waste by these authorities has been challenging.

According to Hyman et, 2013, more than 1.3 billion tons of municipal solid waste (MSW) was generated in 2012 and 2.2 billion tons a year is expected Worldwide by 2025. The environmental pollution associated with municipal solid waste is a common phenomenon in urban setting of the world due to improper management practices[6]. To minimize effluence of these waste, national waste management policies and strategies are put in place, and each country try to apply its own particular style of inventiveness to its own complexities[7]. However according to Chung et al., 2013 Municipal Solid Waste Management (MSWM) is a strategic issue that is often limited by resources requires, realities support, time requirement, conformity with expected outcomes and including numerous aspects. It includes several multifaceted and interdependent problems that need to be clarified in as sensible and logical manner, so that it leads to more and better decisions.

The challenges and problems confronted in the municipal solid waste management has been an issue since the creation of the universe[8].The phenomena has been exacerbated since the industrial revolution and several researchers have discussed its issues[9].Many noted that, the population growth, rapid urbanization, and industrialization resulted in increasing problems of solid wastes.

The disposal and handling of these waste lead to environmental degradation, damage of the ecosystem and pose great risks to public health[10].There is a huge linkage between improper management of urban solid wastes and the environmental pollution. This has resulted to a serious environmental degradation such as land, water, and air pollution and public health risk such as skin disease, asthma, diarrhea, and even skin diseases, etc. mainly due to unselective disposal of wastes on streets and other public areas, drainage bottleneck by indiscriminately dumped wastes, and contamination of water bodies closed to waste stream[11].

As mentioned in Sharholy et al. (2008), MSW in urban areas contained large fraction of compostable materials (40–60%) and inert (30–50%). The relative percentage of organic waste in MSW was generally increasing with decrease in socio-economic status; so rural households generate more organic waste than urban households[12]. It has been observed that the physical and

chemical components of MSW depends upon a number of factors such as food habits, standard of living, degree of commercial activities, seasons etc. where the total MSW generation depends on total population.

As a basis and precondition for Municipal Solid Waste Management (MSWM) systems, quantification and prediction of solid waste generation is very fundamentals[13]. However, MSW prediction cannot be done directly and depends on so many factors. The effective collection and proper disposal of MSW depends greatly upon accurate prediction of generation of solid waste [14].The waste management measure to adopt will depend on the sources, since waste characteristics and composition differ according to source[15]. The problem associated with solid waste management in developing countries cannot be over-emphasized even though the management of solid waste is an essential public services[16]. In many developing nations, the provision of solid waste management services to inhabitants is not full satisfaction[17]. This is due to the fact that the custodian of waste management system has not fully considered the users of the waste management systems. Waste generation being an intrinsic part of living requires a proper examination of various sources from which waste generated[17].

## II. STUDY AREA

The Gambia is a smallest country in continental Africa, bordered by Senegal and extending to Western Coast of Africa between 13<sup>0</sup> and 14<sup>0</sup> N. It covers a total land area of approximately 10, 689 sq. km with a length of about 400km and a width varying from 20 to 48km. It has *Sudano-Sahelian* type of climate, with a short rainy season from June to October and a long dry season lasting from November to May. The average annual rainfall is 900mm and the country witness an average reduction of 275 in annual rainfall since 1951. The mean temperature is lower plateau and upper plateau, with different soil types. The natural drainage is centered on the River Gambia and its tributaries, namely; *Sandougou, Miniminyang, Baobolon, Sofaniama and Bintang Bolong*. The River Gambia, which covers **1130km** long originates from the **Fouta Djallon** highland in Guinea pass through Senegal, the Gambia and empties into the Atlantic Ocean. It has features Sudan Savana woodland vegetation. The Gambia has the following main ecosystem types: forest ecosystems (closed and open woodland ecosystem), agricultural ecosystems (arable and rangeland ecosystems), marine and coastal ecosystems, inland water ecosystem (wetland and terrestrial ecosystems (tree / shrub savanna).



**Figure 1. Map of The Gambia**

According to the 2013 National Population Census, the Gambia population is estimated at 1, 856, 417 with a population growth rate 3.6% per annum (GBoS, 2013). The country’s population density is 174 person per square kilometer. Thus, making the country the 10<sup>th</sup> most densely population in Africa. It has a population which is relatively young with about 46.2% of the population under 15 years of age while 3.2% is 65 years and above, according to the 2013 census results.

The waste management system in The Gambia is faced with several challenges which include inter alia; high population pressure, inadequate public awareness on solid waste, insufficient funding, inadequate equipment for collection and disposal, lack of appropriate waste disposal facilities, low technical capacity mainly at local government authority level (UNEP-GEF Capacity Building For PCBs and U-POPs Consultancy Report 2018). These to greater extent have ramifications on the quality, aesthetic values and health related issues on the immediate environment in the country. Municipalities/ Area Council Authorities are responsible for MSWM and are required to provide an effective and efficient management plan as enshrined in the Local Government Act 2002. However, these authorities face problems that are beyond their

limits due to lacking organization and financial resources[2] and multidimensionality identified as an important shortcomings owing to limited capacity and funding of LGAs.

The aim of this paper is to investigate and analyze the current status of MSWM in the Kanifing Municipality and to analyze to what extent a viable reduction of the municipal solid wastes can be implemented and management systems to be improved in the near future.

Kanifing Municipality is one of the most densely urban settlement in the Gambia. According to 2013 Housing and Population Census conducted by GBoS, revealed that it has a population of 382,096, accounting for 20.3% of the National Population with a population density of 4,274.63 per square kilometer. The Census further indicated that, there are 49,560 households with an average household population size of about 6.50 persons. The population growth stood at 1.7% resulting to 18.39% surge from 322,735 in 2003 and 382,096 in 2013 with a combined land area of 88 sq. km constituting about 0.8% of the total land area of the country.



**Pictorial of the study area (Kanifing Municipality)**

## **Solid Waste Collection, Transportation, Disposal and Recycling practice in Kanifing Municipality**

As enshrined in the Local Government Act, 2002, Sections 48 - 131 and Local Government Finance and Audit Act, 2004, Sections 8, 12, 14, 20 and 23 and other local government provisions. The responsibility of solid waste management within Kanifing Municipality is on the shoulders of the Kanifing Municipal Council (KMC). Within the Municipality, the department of **Environment and Sanitation** is a body charge with the management responsibility of all waste types. However, only the garbage collection just limited to the markets and business places, restaurants and road, main streets and in some residential areas. The collection is just covering small area and the rest of residential areas without collection services due to lack of fund, facilities e.g.; tipper/compactor trucks to collect the garbage. In addition no participation from private companies to take over residential areas in garbage collection. The municipal's **Environment and Sanitation Department** has six zones /blocks all lies within the area map of Kanifing Municipal Administration. These zones /blocks have coordinators together with environmental officers, public health officers, rate collectors and supervisors who are trusted with responsibility in their management.

For any waste management, the effectiveness and efficient collection and transport of waste are of significant importance in reducing waste accumulation[7]. In Kanifing Municipality, the system of collection is both **door to door** and **station type** where Skips and Trailers are placed in strategic locations for communal collection. For ease of management the municipality is divided into **six collection Zones**, which are further subdivided into Blocks. Refuse collection is divided in two shifts, morning shift (8:00a.m - 3:30 p.m.) and afternoon shift (4:00p.m - 12:00 mid night).

The types of collection systems are, **Door-to-door collections**, the onus is on the households to place their refuse along the route of the collection vehicle (usually contained in sacks and buckets). **Communal collection points** where the residents take their refuse to the collection point (Skip or Trailer). The criteria for adopting either of the two systems is not strictly defined, but in general is guided by the following: -

**Population density** - door-to-door collection is used in relatively less densely populated middle and mostly high income

areas while **communal collection points** are used in the low-income areas and more densely populated areas and where indiscriminate/illegal dumping of refuse is common.

Inception Report for the Development of Five-Year Waste Management Plan for Kanifing Municipal Council, 2015 stated that, the weak financial muscle of the municipality hindered the management operations on solid waste management as result waste management continuous to be the main challenge for this city. It was also reported that, 45% of the vehicle fleet of the municipality used in the collection and transportation of waste were road worthy. Under these circumstances the choice of using a trailer or skip is guided by availability, volume of refuse generated and the existence of door to door services. Despite the efforts of the KMC and other operators, solid waste management in the Kanifing Municipality is inadequate as visually evidenced by the existence of uncollected refuse at various locations within the municipality[18]. There are no sanitary landfills and waste is dumped at official designated dumpsite at Bakoteh. This dumpsite as commonly known as "Bakoteh Dumpsite" is the official dumping ground for all the waste generated within this municipality. However, this site to certain extent pose significant health threat to the residents and the environment as a whole[18]. In general, the Gambia as a country does not have proper infrastructure to deal with the solid waste issues since the colonial era and as such waste is dumped indiscriminately and haphazardly with minimal or no proper management which resort to open burning thus resulting in air pollution.

Study revealed that, Kanifing Municipality generated 79,935 tons of waste, and 8% of the country total wastes. 52,195 tons of this waste or 65.3% is dumped at the Bakoteh dumpsite and 20,805 tons or 26% is burnt at home (UNEP-GEF Capacity Building for PCBs and U-POPs Consultancy Report 2018). A cause for serious concern is that most localities dispose of, and sometimes burn, their waste in random open dumps that do not adherence to health and safety requirements. The municipality also use the burning method for volume reduction for financial reasons. The budget for disposal is very small and does not cover further treatment.

The performance of the disposal services by the municipality continuous to deteriorate due to limited finance.

### Solid waste handling in Market place



Source: UN-Habitat/Kanifing Urban Profile, 2011

Currently, reports indicated that Kanifing Municipality does not employ any sorting or recycling processes for waste. Sorted recyclable wastes from households are also uncollected. In addition, specific containers for waste segregation are unavailable. People throw away materials as waste regardless of their possible benefits. These types of waste mainly include iron, aluminum, pipes, plastic bags, plastics, magazines, and newspapers.

#### Solid Waste Generation in Kanifing Municipality

The quantities of solid waste produced in this municipality are huge and its generation is influenced by the affluence and progress in standard of living of inhabitants. According to the report (GPA, 2002) on Solid Waste Management Study for Kanifing and Brikama, per capita waste generation was estimated at 0.44kg. In addition, the report on Urban Profiling for Kanifing conducted in 2011 by UN HABBITAT indicated that the tonnage of refuse generated on a daily basis per person within this

municipality is estimated at 0.44 kg, totaling to 142 metric tons daily. Furthermore, according to the Environment and Sanitation Unit of the Kanifing Municipality the daily waste collection is estimated at 300 metric tons. The seasonal variation contribute daily changes in waste generation of this area. They Unit also informed that during rainy season, the waste generation is higher than the dry season. The socioeconomic indicators as well as the degree of nation's development progress influence the generation of waste in any area of a country, this is the story of the Kanifing municipality. However, the difference in waste generation between cities in developed countries (1.5-2kg/person/day) and those in developing nations generally less than 1kg/person/day This significant difference is due to consumption patterns, as industrialized nations consumes more product and use more packaging[19].

#### Estimated Solid waste generated by households in 2014/2015 in tons by type of waste and LGA

LGA /Municipality	Papers %	Plastic %	Organic %	Metal & iron %	Textile %	Other %	Total %	Total (in tons)
Banjul	47	18	31	1	2	1	100	6645.74
Kanifing	22	6	46	0	1	25	100	65690.05
Brikama	9	6	76	0	2	7	100	65157.03
Mansakonko	24	4	51	0	1	20	100	7602.60
Kerewan	18	4	48	2	1	27	100	20377.27
Kuntaur	17	27	38	1	6	11	100	6858.50
Janjabureh	24	3	42	0	1	30	100	11611.23
Basse	17	8	53	0	4	18	100	9829.03
Average %	22	9	53	0	2	14	100	193771.45

Source: NEA, 2015

#### Solid Waste Composition in Kanifing Municipality

According to a consultancy report conducted in February 2018 under UNEP-GEF Capacity Building For PCBs and U-POPs

for the Gambia indicated that, solid waste composition in Kanifing Municipality were in various forms and could be classifies into the following among others; sand, Organic matter related waste,

tailoring waste, textiles, batteries cells, Plastics (plastic bags, old plastic containers), Metal (tins, old basins, Pieces of corrugated iron sheets, aluminum cans), old tiers, old floor carpet covering, wood, paper, cartons, electronic waste, disposable baby dippers, insecticide spray can, sponge mattress, medical related waste, empty Rice bags, glasses, vehicle parts, construction waste and abattoir related waste.

The sources of these waste found to be generated from households and commercial sector which includes institutions, super-markets, restaurants, workshops, agricultural material shops, hotels among others also contribute significantly in generating waste within the urban setting. Studies also indicated that principal components of generated wastes among others are paper/cartons (83%), plastics (80%), organic matter (40%), metals (30%) and glass (27%) (GAP, 2002). It can be further noted that most of the waste generated by the commercial establishment can be recovered, recycled and more importantly, the generation of hazardous waste by the sector seems very negligible.

### III. EXISTING WASTE MANAGEMENT RELATED LEGISLATIONS IN THE GAMBIA

The general waste management in the Gambia is the responsibility of the Ministry of Local Government and Lands (MOLGL), which supervises the Municipalities/Area Councils. However, the National Environment Agency (NEA) acts as the regulatory authority under the auspices of the Ministry of Environment, Climate Change and Natural Resources (MECCNAR). The Municipalities/Area Councils are responsible for the collection and disposal of solid waste through their Waste Management Departments/Units and their Environmental Health and Sanitation Departments. The policy framework guiding the management of waste includes the Public Health Act (1990), The Physical Planning and Development Control Act, 1990 and Regulations, 1995; The National Environment Management Act 1994 (Part VI, Section 28; 1&2); The Environmental Protection, Prevention of Dumping Act, 1998 and Anti-littering Regulation 2007. The National Waste Management Bill 2003, which is expected to address the implementation of problems associated with waste management and pollution that could not be addressed by the previous waste related legislation is being reviewed.

The challenges associated with managing the solid waste pollution persists, the government of The Gambia device mechanisms to mitigate the issues by enhancing the abilities of municipalities. The development of legislations that are geared towards developing public infrastructure and services particularly to the poor so that such vital services are available in their various areas is longer overdue.

### IV. EVALUATION OF WASTE COLLECTION AND DISPOSAL

Currently, MSWM status and problems in this municipality is surrounded by an increase in the population couple with upsurge in affluent of inhabitants resulting in huge increase in the generation and composition of MSW. Comparing with the increasing rates of MSW generation, little has been done concerning its management. However, not only Kanifing Municipal Council is adequate in the sustainable management of

the waste generated, but also individuals are key in the effective and efficient management of MSW. Therefore, an Integrated Waste Management System should be built in order to improve the holistic approach to enhance the sustainable MSWM system and reduce the impacts of waste to the environment and people at large.

The main issues in the management is circle around inadequate and inefficient collection and inappropriate final disposal. Other major challenges includes poor infrastructure and institutional framework, limited stakeholders' participation, public attitude towards waste management, lack of technical expertise and no sanitary landfill. Unwillingness of some business owners in paying garbage collection fees, Low salaries for the cleaners and deteriorating economy has made things difficult in the markets, etc.

Therefore, improving solid waste management in Kanifing Municipality coverage of waste collection and final disposal should be of the highest priority to reduce the risk of environmental hazards. The adoption of the Integrated Solid Waste Management (ISWM) approach is pivotal to maximize the efficiency of current systems[18]. The approach sets zero waste generation as a target and consists of a hierarchy of coordinated management options that seek to minimize the amount of waste that will be available for land filling or final disposal[20]. The waste management hierarchies emphasized on certain key elements which include avoid/prevent, reduce/reuse, recycle, compost, incinerate and landfill.

### V. RECOMMENDATIONS

1. There is urgent needs to recognize and address the perennial economy crises that symbolizes the waste sector in the Kanifing Municipality. In this esteem, the central government can significantly improve its fund allocation to Municipalities/Area councils in a softer way and fixed schedule in order to avoid delay payments for waste who require funds to meet the operational costs of solid waste collection and disposal.
2. The Municipalities /Area Councils need to be supported through local people to improve revenue mobilization. Such support can be achieved by attracting qualified finance and accounting staff professionals who can identify additional sources of funds, such as taxes on properties and business. Employing such qualified persons can also improve the financial management practices of the authorities by plugging leakages and preventing corruption. Additional revenue can also be raised from clients of waste disposal services.
3. It is fundamental for any supportive policy frameworks, knowledge and capacity to develop plans / systems, proper use of environmentally sound technologies and appropriate financial instruments to support sustainable waste management requires data on present and anticipated situation. Thus, there is need for LGAs or municipalities to generate its own primary data on its present and anticipated waste situation as this could be used to develop plans or systems that will ensure environmentally sound management of waste supported

by appropriate financial instruments and legal frameworks.

4. There is need for collaboration from both public and the government in enforcing waste related legislations to enhance sustainable waste management across the country.
5. To achieve a sustainable MSWM the municipalities must foresee what amount and composition of the generated waste. In addition, the authorities need to incorporate waste management at the center of the city planning to enhance effective and efficient waste management.
6. Public participation in MSWM is insufficient since residents have a relatively low awareness of environmental protection and their participation is very essential to support waste planning and decision making in MSWM. Thus, the need for authorities to improve public awareness of waste separation and recycling to enhance MSWM.

#### REFERENCES

- [1] Lilliana Abarca Guerrero a, Ger Maas a, William Hogland b, Solid waste management challenges for cities in developing countries. 23 October 2013.
- [2] Guerrero, L.A., G. Maas, and W. Hogland, Solid waste management challenges for cities in developing countries. *Waste management*, 2013. 33(1): p. 220-232.
- [3] Camilleri-Fenech, M., et al., Where do islands put their waste?—A material flow and carbon footprint analysis of municipal waste management in the Maltese Islands. *Journal of Cleaner Production*, 2018. 195: p. 1609-1619.
- [4] Ellis, B., World Bank: Global waste generation could increase 70% by 2050. 2018.
- [5] Ansari, M.A.S.S.M.R.L.S.S.A., Municipal Solid Waste Management in Moradabad City, India. 25 June, 2011.
- [6] De Feo, G., et al., Improving the efficacy of municipal solid waste collection with a communicative approach based on easily understandable indicators. *Science of the Total Environment*, 2019. 651: p. 2380-2390.
- [7] Cetrulo, T.B., et al., Effectiveness of solid waste policies in developing countries: A case study in Brazil. 2018.
- [8] G. Pouloupoulos<sup>1</sup>, V.J.I.K.M.G.K.D.T.Y.S.R.R.B.S.Y.A.S., Current municipal solid waste management in the cities of Astana and Almaty of Kazakhstan and evaluation of alternative management scenarios. 14 February 2018.
- [9] Panayotou, T., *ECONOMIC GROWTH AND THE ENVIRONMENT* 2012.
- [10] Makoni, F., et al., Impact of waste disposal on health of a poor urban community in Zimbabwe. *East African medical journal*, 2004. 81(8): p. 422-426.
- [11] Naserzadeh, Z., F. Atabi, and S.Y. Sinaki, Environmental analysis of municipal solid waste combustion in a fluidized bed 2018.
- [12] Sharholly, M., et al., Municipal solid waste management in Indian cities—A review. *Waste management*, 2008. 28(2): p. 459-467.
- [13] Laurent Parrot a, Joel Sotamenou b, Bernadette Kamgnia Dia b, <Ref. 1\_Cameroon.pdf>. Municipal solid waste management in Africa: Strategies and livelihoods in Yaoundé, Cameroon, 24 July 2008.
- [14] Xiang, Y.L., et al., Study of the effect mechanism of municipal solid waste gasification conditions on the production of H<sub>2</sub> and CO using modelling technique. *Journal of Environmental Management*, 2019. 230: p. 301-310.
- [15] Tchobanoglous, G., et al., *Integrated solid waste management: engineering principles and management issues*. Vol. 949. 1993: McGraw-Hill New York.
- [16] Ochieng, W.O., *Planning for Domestic and Commercial Solid Waste Management in the Informal Settlements: A Case Study of Langas in Eldoret Municipality*. 2004, University of Nairobi.: Unpublished Thesis.
- [17] A.J. Morrissey, J.B., *Waste management models and their application to sustainable waste management*. 17 September 2003.
- [18] Badgie, D., *SOLID WASTE MANAGEMENT SYSTEM IN THE KANIFING MUNICIPAL COUNCIL AREA, THE GAMBIA*. 2010.
- [19] Zhiyong, Y.L., Min Zhong, Guozhong Shi, Qibin Li, Dan Zeng, Yu Zhang, Yongqiang Fei, Yanhua Xie, Influencing factors of domestic waste characteristics in rural areas of development countries. 22 November 2017.
- [20] R. L. Vermaa, G. Borongana, M. Memon<sup>\*</sup>, *Municipal Solid Waste Management in Ho Chi Minh City, Viet Nam, Current Practices and Future Recommendation*. 2016.

#### AUTHORS

**First Author** – Foday N.K. Fatty, Institute of Environmental Management and Sustainable Development, College of Environmental Science and Engineering, Tongji University  
**Second Author** – Lamin Komma, World Maritime University, Malmo, Sweden